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DUAL-OPENING SAMPLE CONTAINERS, FLUID SAMPLING DEVICE AND METHOD OF USING SAME

Provisional Application

Applicant claims priority of his previously filed Provisional patent application filed on March 3, 2003 and having a serial number of 60/451,196.

Field of Invention

This invention pertains to fluid collection equipment for analytical testing, such as water well sample collection equipment for the environmental industry. More particularly, the invention relates to dual opening sample containers and sampling devices for use with such containers.

Background of the Invention

Groundwater sampling in the field of environmental pollutant characterization traditionally consists of removing a specified volume of water from a groundwater well ("purging"), monitoring physical and chemical parameters of the "purged" water for indication that "fresh" ground water has been drawn into the groundwater well from the surrounding formation. This is accomplished by pumping or bailing water from the well and measuring physical and chemical parameters with instruments at the ground surface (e.g. thermometer, pH meter, electrical conductivity meter).

After purging, water samples are commonly taken from the well using a bailer and poured into containers for storage/transport to an analytical laboratory for testing. The storage and transport containers are made out of various materials such as glass or polyethylene and in

sizes ranging typically from 40 milliliters to 1 liter. The size and type of container are selected based on requirements of the analysis to be performed. Volatile organic compounds such as benzene or trichloroethene are stored and transported in specifically-sized 40 milliliter volatile organic analysis (VOA vials). VOA vials are sized so that they can be placed in automated laboratory analytical equipment that use that size vial. Other analytes (e.g. metals, pesticides) are stored in different size and material containers to avoid adsorbance to the bottle material and to provide sufficient volume for analysis.

Improvements to purging/sampling techniques have been introduced by others to limit the amount, or eliminate outright, the water that needs to be "purged" from a groundwater well. These techniques include low-flow purging and no-purge "passive" methods. These methods may reduce or eliminate the need to bail water from the well after purging, but sample bottles are filled at the ground surface by pouring in the open air.

The following briefly describe traditional and newer sampling methods and equipment, and some of the disadvantages of each.

<u>The Bailer</u>

Fluid sampling equipment traditionally consists of some type of bailer, scoop, or pail that may or may not have a bottom filling device and some type of closure, such as a check ball or valve to contain the fluid. The sampling equipment is used to transport the fluid from the remote sampling location (inside a well or tank) to the point where the person conducting the sampling can transfer the fluid into appropriate containers for transport and/or testing. In the environmental industry, sampling from groundwater monitoring wells commonly consists of lowering a bottom-filling bailer into the well water, then raising the bailer, causing a check

ball to seat--retaining the water within the bailer tube. Once the bailer is brought to the surface, the water sample is poured into containers for shipment to an analytical laboratory for testing. This method of groundwater sample collection has several disadvantages. These include:

a) The sampled water must be poured into separate containers after the bailer is brought from the remote location to the sampling personnel.

b) Volatile chemicals, which are commonly contaminants of concern in the groundwater to be tested, tend to off-gas when exposed to air during movement of the open sampling device and pouring into separate containers.

c) Lowering and raising a sampling device into a groundwater well, or other fluid containing vessel, can agitate solids into suspension (induce turbidity) within the liquid to be sampled.

d) Agitated solids, once enclosed in a bailer, are prevented from falling out of a bailer-type sampling device because of a solid bottom or check ball.

e) Lowering a bailer through a liquid allows only limited flow through of fresh liquid, limiting the utility of sampling stratified liquids.

<u>The Diffusion Bag Sampler</u>

The diffusion bag sampler (U.S. Patent Nos. 5,804,743; 6,196,074) is a no-purge, passive, sample collection device that removes some disadvantages of the bailer, but has additional disadvantages. This device consists generally of a closed polyethylene (or other material) bag with or without structural support, filled with water. In its typical use, the filled bag is

lowered into a groundwater well, left for a period of time (typically two days to two weeks) while volatile organic contaminants diffuse from the surrounding water through the bag into the water contained inside the bag. The sampler is raised to the surface, and water sample is poured into separate containers for transport to an analytical laboratory. This method of groundwater sample collection has several disadvantages. These include:

a) Like the bailer, water samples collected with the diffusion bag sampler must be poured into separate containers for transport to an analytical laboratory.

b) Diffusion bag samplers are limited to chemicals that will diffuse through a polyethylene (or other material) membrane. Many chemicals of concern for groundwater contamination will not diffuse through polyethylene, including for example, dissolved metals; or diffuse poorly, such as methyl tertiary butyl ether (MTBE), acetone, and methyl ethyl ketone (MEK).

c) Diffusion bag samplers must be left in place for as long as two weeks for the diffusion process to reach full equilibrium between the inside and outside of the bag.

d) Different chemicals diffuse through the membrane at different rates, meaning that if water chemistry changes during the time the diffusion bag is deployed, it is uncertain all chemical are indeed in equilibrium inside and outside the diffusion bag.

The Niskin Bottle

The fluid sampling equipment collectively described here as the "Niskin Bottle" consists generally of an open tube with a closure device at either end that is triggered (closed)

remotely (U.S. Patent Nos. 4,037,477; 4,091,676). The sampler is ordinarily used for sea- or lake-water sampling at depth. The closure devices consist of ball valves or other closure means attached by a rubber band through the openings of the open tube. The sampler is open during deployment or opened at the designated sample point. Fluid enters the bottle at either end and is trapped within the sampler when the closures are triggered remotely. The sampler is raised to the surface, and water sample is poured into separate containers for transport to an analytical laboratory. This method of water sample collection has several disadvantages. These include:

a) Like the bailer, water samples collected with the Niskin Bottle sampler must be poured into separate containers for transport to an analytical laboratory.

b) The Niskin Bottle in its commonly-used embodiment is large and bulky. Its size precludes it from being used in typical ground water monitoring wells used in the environmental industry (2 to 4 inch inside diameter is most common).

c) The trigger mechanism and outer appurtenances of the Niskin Bottle also do not lend themselves to insertion in groundwater monitoring wells even if they were small enough because projections from the bottle are subject to binding and catching on casing joints within monitoring wells. This could cause premature triggering of the closure mechanism or the sampler becoming stuck within the well, an obvious disadvantage for collecting a water sample from a well.

The Kabis Sampler

The Kabis Sampler (U.S. Patent Nos. 5,454,275; 5,686,673) solves some of the problems of the bailer by utilizing a standard volatile organic analysis vial (a 40 milliliter vial) to collect samples in a monitoring well—avoiding the pouring of sample into separate sample containers. However, this method of water sample collection has several disadvantages. These include:

a) During deployment and submergence, the Kabis sampler degasses by bubbling air through vents in the sampler. This may result in off-gassing of volatile organic compounds within the well.

b) The sample vial remains open while the sampler is brought from its remote location (in a well, for example) and until the user screws on the vial cap. This results in exposure of the water sample to the atmosphere, possibly allowing VOC off-gassing.

c) The sample vial is open only at one end. Like the bailer, solid material can become entrapped in the sample vial.

d) Deployment of the sampler also tends to agitate water in the well and can increase turbidity in collected samples.

The Kemmerer Sampler

The Kemmerer sampler (see U.S. Patent No. 5,487,314) is similar to the Niskin Bottle in that it is comprised generally of a hollow tube with end closures that are triggered and close

mechanically. A fluid sample is contained within the apparatus for retrieval from a remote source. Like the other examples described above, this sampling device has several disadvantages. These include:

a) Like the bailer, water samples collected with the Kemmerer sampler are typically poured into separate containers for transport to an analytical laboratory.

b) The Kemmerer sampler in its commonly-used embodiment is large and bulky. Its size precludes it from being used in typical ground water monitoring wells used in the environmental industry (2 to 4 inch inside diameter is typical).

c) The trigger mechanism and outer appurtenances of the Kemmerer sampler also do not lend themselves to insertion in groundwater monitoring wells even if they were small enough because projections from the bottle are subject to binding and catching on casing joints within monitoring wells. This can cause premature triggering of the closure mechanism or the sampler becoming stuck within the well, an obvious disadvantage for collecting a water sample from a well.

Other Tubular-Body Fluid Samplers

Several other examples of tubular-body samplers with various closures exist in the prior art. These other samplers are exemplified by patents such as U.S. Patent Nos. 5,341,693; 5,094,113; 4,590,810; 4,078,433; and 5,410,919. Various closure mechanisms typically differentiate the devices.

Each of the prior art devices described above, except the Kabis sampler, require pouring of collected fluid into separate sample containers for transport and/or chemical testing at an analytical laboratory. The prior art described above includes exposure of the collected sample to the atmosphere during pouring of fluid into separate sampling containers or closure of the sample containers at the surface. This is a clear disadvantage, especially for volatile chemicals that may escape the sample and bias results.

It is an objective of the present invention to provide a means to provide a sample container that permits fluid samples to flow freely through the container to avoid well purging for groundwater sample collection and to minimize induced turbidity and solids in samples. It is a further objective to provide a sample container that may be remotely closed securely within the fluid sample so as to collect self-contain samples in a manner that precludes exposure of the sample to the atmosphere from the time of sample collection, throughout storage and transport, to the laboratory testing apparatus.

It is a still further objective of the invention to provide a fluid sampling device for remotely deploying and securing one or more sample containers. It is yet a further objective to provide securing caps for the sample container to prevent leakage and contamination during transport and storage of the sample containers so as to reliably test virtually any chemical or physical parameter in the fluid. It is still a further objective to provide a method of drawing a sample from the sample container without disturbing the container seals. It is another objective of the invention to provide a means for pressurizing the contents of the sample container without disturbing the container seals. It is yet another objective to provide a combination sample container and fluid sampling device that can fit smoothly into narrow pipes and passageways. Finally, it is an objective of the invention to provide a durable and

inexpensive fluid sampling system that is adaptable to a variety of fluid sampling environments.

While some of the objectives of the present invention are disclosed in the prior art, none of the inventions found include all of the requirements identified.

Summary of the Invention

The present invention addresses all of the deficiencies of fluid sampling and sample container inventions and satisfies all of the objectives described above.

(1) A dual-opening sample container can be fabricated from the following components. A body is provided. The body is formed of substantially rigid, fluid impermeable material and has a hollow cavity in communication with first and second open ends. First and second end seals are provided. The end seals are sized and shaped to fit sealably the first and second open ends. A first elastic member is provided. The first elastic member urges the first and second end seals to removably close the first and second open ends.

(2) In a variant of the invention, first and second activating protrusions are provided. Each of the activating protrusions extends outwardly from outer ends of the first and second end seals. The protrusions are sized, shaped, and located to removably engage means for holding open the end seals.

(3) In a further variant, the activating protrusion further includes holes, loops or hooks for removable engagement of the means for holding open the end seals.

(4) In still a further variant, the first and second end seals include holes, loops or hooks for attachment to the first elastic member.

(5) In another variant of the invention, the first elastic member is located within the hollow cavity.

(6) In still another variant, the first elastic member is located outside of the sample container.

(7) In a further variant, first and second securing caps are provided. The securing caps are sized and shaped to retain the first and second end seals in sealable connection with the first and second open ends of the sample container.

(8) In still a further variant, the first and second open ends of the sample container have an external thread and the first and second securing caps have a mating, internal thread.

(9) In yet a further variant, the first and second open ends of the sample container have an external bayonet mount and the first and second securing caps have a mating, internal bayonet mount.

(10) In another variant of the invention, at least one of the first and second securing caps includes a septa permitting introduction of a syringe needle and subsequent resealing of the securing cap.

(11) In yet another variant, the first and second end seals comprise a substantially rigid core. The core is surrounded by a resilient material.

(12) In a further variant, the substantially rigid core and the resilient material are coated with substantially chemically inert material.

(13) In still a further variant, the substantially chemically inert material is selected from the group that includes tetrafluoroethene, polytetrafluoroethene, perfluoralkoxy and fluoroethylpropylene.

(14) In yet a further variant, the first and second end seals include a compressible seal. The seal permits an elevation of fluid pressure within the sample container upon compression of the seal.

(15) In another variant of the invention, at least one of the first and second end seals is formed of a resilient material. The resilient material permits an elevation of fluid pressure within the sample container upon compression of the seal.

(16) In still another variant, the first and second end seals have a first side. The first side is substantially conical and is sized and shaped to fit sealably into the first and second open ends of the sample container.

(17) In yet another variant, the first and second end seals have a second side. The second side has a substantially flat surface to mate with a flat inner side of either of the first and second securing caps.

(18) In a further variant of the invention, at least one of the first and second end seals has a membrane central portion. The central portion permits introduction of a syringe needle through the end seals.

(19) In still a further variant, the sample container is formed from material selected from the group that includes glass, steel and plastic.

(20) In another variant, the outside diameter of the sample container ranges from 8 mm to 60 mm.

(21) In still another variant, the overall length of the sample container ranges from 20 mm to 150 mm.

(22) In yet another variant, the sample container has a capacity ranging from 2 ml to 2400 ml.

(23) In a further variant of the invention, a fluid sampling device with dual-opening sample containers includes the following components. At least one sample container is provided. The container is formed of substantially rigid, fluid impermeable material and has a hollow cavity in communication with first and second open ends. First and second end seals are provided. The end seals are sized and shaped to fit sealably the first and second open ends. A first elastic member is provided. The first elastic member urges the first and second end seals to removably close the first and second open ends. A support platform is provided. The support platform is removably attached to the sample container and has a fixture for removable connection to a raising and lowering device. The support platform has first and second movable attachment members. The attachment members are sized, shaped and located to removably engage the first and second end seals. A trigger is provided. The trigger is located to move the attachment members from a first position to a second position. When the sample container is attached to the support platform and the first and second end seals are engaged by the first and second attachment members in the first position, the sample container will be open. The support platform may then be lowered into a fluid source by the raising and lowering device and the trigger pulled to move the first and second attachment members to the second position releasing the first and second end seals. This permits the first elastic member to urge the first and second end seals to seal the first and second open ends of the sample container. This causes a fluid sample to be sealed within the sample container. The support platform may then be withdrawn from the fluid source with the sealed sample container and the fluid sample.

(24) In a variant, a trigger sheath is provided. The sheath is sized and shaped to fit slidably over the trigger and is attached at a first end to the support platform and extends upwardly about the trigger.

(25) In another variant, a second elastic member is provided. The second elastic member urges the attachment members to the first position.

(26) In still another variant, first and second activating protrusions are provided. Each of the activating protrusions extends outwardly from outer ends of the first and second end seals and is sized, shaped, and located to removably engage the movable attachment members.

(27) In yet another variant, the activating protrusion include holes, loops or hooks for removable engagement of the movable attachment member.

(28) In a further variant, the first and second end seals include holes, loops and hooks for attachment to the first elastic member.

(29) In still a further variant, the first elastic member is disposed within the hollow cavity.

(30) In yet a further variant, the first elastic member is disposed outside of the sample container.

(31) In another variant of the invention, first and second securing caps are provided. The securing caps are sized and shaped to retain the first and second end seals in sealable connection with the first and second open ends of the sampling container.

(32) In still another variant, the first and second open ends of the sampling container have an external thread and the first and second securing caps have a mating, internal thread.

(33) In yet another variant, the first and second open ends of the sampling container have an external bayonet mount and the first and second securing caps have a mating, internal bayonet mount.

(34) In a further variant, at least one of the first and second securing caps includes a septa that permits introduction of a syringe needle and subsequent resealing of the securing cap.

(35) In still a further variant, the support platform has a hollow body. The hollow body is sized and shaped to enclose the sample container.

(36) In yet a further variant, the support platform further comprises at least one fluid-permeable protective end cover. The end cover partially encloses an open end of the hollow body.

(37) In still a further variant, the fixture for removable connection to a raising and lowering device is attached to the end cover.

(38) In another variant, the sampling container is sized and shaped to substantially enclose the support platform within outer horizontal dimensions of the sample container.

(39) In still another variant, the first and second end seals include a substantially rigid core. The core is surrounded by a resilient material.

(40) In yet another variant, the substantially rigid core and the resilient material are coated with substantially chemically inert material.

(41) In a further variant, the substantially chemically inert material is selected from the group that includes tetrafluoroethene, polytetrafluoroethene, perfluoralkoxy and fluoroethylpropylene.

(42) In still a further variant, the first and second end seals include a compressible seal. The seal permits an elevation of fluid pressure within the sample container upon compression of the seal.

(43) In yet a further variant, at least one of the first and second end seals is formed of resilient material. The resilient material permits an elevation of fluid pressure within the sample container upon compression of the seal.

(44) In still a further variant, the first and second end seals have a first side. The first side is substantially conical and is sized and shaped to fit sealably into the first and second open ends of the sample container.

(45) In another variant of the invention, the first and second end seals have a second side. The second side has a substantially flat surface to mate with a flat inner side of either the first or second securing caps.

(46) In still another variant, at least one of the first and second end seals have a membrane central portion. The central portion permits introduction of a syringe needle through the end seals.

(47) In yet another variant, the sample container is formed from material selected from the group that includes glass, steel and plastic.

(48) In a further variant, the outside diameter of the sample container ranges from 8 mm to 60 mm.

(49) In still a further variant, the overall length of the sample container ranges from 20 mm to 150 mm.

(50) In yet a further variant, the sample container has a capacity ranging from 2 ml to 2400 ml.

(51) In another variant of the invention, a method of sampling fluid using a fluid sampling device with dual-opening sample containers, includes the steps of providing at least one sample container. The container is formed of substantially rigid, fluid impermeable material and has a hollow cavity in communication with first and second open ends of the sample container. Providing first and second end seals for the container. The end seals are sized and shaped to fit sealably to the first and second open ends. Providing a first elastic member. The first elastic member urges the first and second end seals to removably close the first and second open ends. Providing a support platform.

The support platform is removably attached to the sample container and has a fixture for removable connection to a raising and lowering device. The support platform has first and second movable attachment members. The attachment members are sized, shaped and located to removably engage the first and second end seals. Providing a trigger. The trigger is located to move the attachment members from a first position to a second position. Attaching the support platform to the sample container with the movable attachment members in said first position, engaging the first and second end seals so as to maintain the end seals in an open position. Attaching the support platform to the raising and lowering device.

Lowering the support platform into a fluid source. Pulling the trigger to move the attachment members from the first position to the second position, thereby sealing the first and second open ends with a fluid sample inside of the hollow cavity. Raising the support platform from the fluid source. Removing the sealed sample container from the support platform. When the sample container is removed from the support platform, it may be sent for testing and examination without contamination from elements outside the fluid source.

(52) In yet another variant, the method of sampling fluid using a fluid sampling device with dual-opening sample containers includes the additional steps of providing first and second securing caps. The securing caps are sized and shaped to retain the first and second end seals in sealable connection with the first and second open ends of the sampling container. Attaching the first and second securing caps to the first and second open ends of the of the sample container.

(53) In a final variant, the method of sampling fluid using a fluid sampling device with dual-opening sample containers includes the additional steps of providing at least one of the first and second end seals with a membrane central portion. The central portion permits introduction of a syringe needle through the end seal. Providing first and second securing caps. The securing caps are sized and shaped to retain the first and second end seals in sealable connection with the first and second open ends of the sampling container. At least one of the securing caps has a septa to permit introduction of a syringe needle and subsequent resealing of the securing cap. Inserting a syringe needle through the septa and the membrane central portion. Withdrawing a fluid sample from the sample container. Removing the syringe needle from the septa and the membrane central portion. Depositing the fluid sample in a test facility.

An appreciation of the other aims and objectives of the present invention and an understanding of it may be achieved by referring to the accompanying drawings and the detailed description of a preferred embodiment.

Description of the Drawings

Figure 1 is a perspective view of a dual opening sample container according to the present invention, illustrating attached securing caps;

Figure 2 is an exploded, side elevational view of the **Figure 1** embodiment, illustrating an end seal, an elastic member and securing caps with internal thread;

Figure 2A is a side elevational view of the **Figure 1** embodiment, illustrating a bayonet mount securing cap;

Figure 3 is a side elevational view of a first embodiment of a fluid sampling device enclosing the sample container, illustrating attachment members holding the end seals in a first, open position;

Figure 4 is a perspective view of the **Figure 1** embodiment, illustrating the end seals in an open position;

Figure 5 is a side elevational view of the **Figure 3** embodiment, illustrating attachment members having released the end seals to a second, closed position;

Figure 6 is a perspective view of the **Figure 1** embodiment, illustrating the end seals in a closed position;

Figure 7 is a perspective view of a back side of a second embodiment of a fluid sampling device supporting the sample container, illustrating attachment members holding the end seals in a first, open position;

Figure 8 is a perspective view of a front side of the **Figure 7** embodiment, illustrating attachment of the sample container;

Figure 9 is a rear elevational view of a third embodiment of a fluid sampling device that fits within the outer diameter of the sample container;

Figure 10 is a bottom side plan view of the **Figure 9** embodiment, from the point of view **10-10**, illustrating the placement of the fluid sampling device within the outer diameter of the sample container;

Figure 11 is a side elevational view of the **Figure 9** embodiment; and

Figure 12 is a side elevational view of a fourth embodiment of a fluid sampling device illustrating a sample container having an external elastic member.

Detailed Description of the Preferred Embodiment

(1) **Figures 1, 2, 4, 5** and **8** illustrate a dual-opening sample container **10** that can be fabricated from the following components. A body **15** is provided. The body **15** is formed of substantially rigid, fluid impermeable material and has a hollow cavity **20** in communication with first **25** and second **30** open ends. First **35** and second **40** end seals are provided. The end seals **35, 40** are sized and shaped to fit sealably the first **25** and second **30** open ends. A first elastic member **45** is provided. The first elastic member **45** urges the first **35** and second **40** end seals to removably close the first **25** and second **30** open ends.

(2) In a variant of the invention, as illustrated in **Figure 3**, first **50** and second **55** activating protrusions are provided. Each of the activating protrusions **50, 55** extends outwardly from outer ends **60, 65** of the first **35** and second **40** end seals. The protrusions **50, 55** are sized, shaped, and located to removably engage means **70** for holding open the end seals **35, 40**.

(3) In a further variant, as illustrated in **Figures 1, 2, 4, 5** and **8**, the activating protrusion **50, 55** further includes holes **75**, loops (not shown) or hooks (not shown) for removable engagement of the means **70** for holding open the end seals **35, 40**.

(4) In still a further variant, the first **35** and second **40** end seals include holes **80**, loops (not shown) or hooks (not shown) for attachment to the first elastic member **45**.

(5) In another variant of the invention, the first elastic member **45** is located within the hollow cavity **20**.

(6) In still another variant, as illustrated in **Figure 12**, the first elastic member **45** is located outside of the sample container **10**.

(7) In a further variant, as illustrated in **Figures 1** and **2**, first **85** and second **90** securing caps are provided. The securing caps **85, 90** are sized and shaped to retain the first **35** and second **40** end seals in sealable connection with the first **25** and second **30** open ends of the sample container **10**.

(8) In still a further variant, as illustrated in **Figure 2**, the first **25** and second **30** open ends of the sample container **10** have an external thread **95** and the first **85** and second **90** securing caps have a mating, internal thread (not shown).

(9) In yet a further variant, as illustrated in **Figure 2A,** the first **25** and second **30** open ends of the sample container **10** have an external bayonet mount **105** and the first **85** and second **90** securing caps have a mating, internal bayonet mount **110**.

(10) In another variant of the invention, as illustrated in **Figure 1**, at least one of the first **85** and second **90** securing caps includes a septa **115** permitting introduction of a syringe needle (not shown) and subsequent resealing of the securing cap **85, 90**.

(11) In yet another variant, as illustrated in **Figure 2**, the first **35** and second **40** end seals comprise a substantially rigid core **125**. The core **125** is surrounded by a resilient material (not shown).

(12) In a further variant, the substantially rigid core **125** and the resilient material are coated with substantially chemically inert material (not shown).

(13) In still a further variant, the substantially chemically inert material is selected from the group that includes tetrafluoroethene, polytetrafluoroethene, perfluoralkoxy and fluoroethylpropylene.

(14) In yet a further variant, as illustrated in **Figure 2**, the first **35** and second **40** end seals include a compressible seal **140**. The seal **140** permits an elevation of fluid pressure within the sample container **10** upon compression of the seal **140**.

(15) In another variant of the invention, at least one of the first **35** and second **40** end seals is formed of a resilient material (not shown). The resilient material permits an elevation of fluid pressure within the sample container **10** upon compression of the seal **35, 40**.

(16) In still another variant, as illustrated in **Figures 2, 4, 8, 11** and **12**, the first **35** and second **40** end seals have a first side **150**. The first side **150** is substantially conical and is sized and shaped to fit sealably into the first **25** and second **30** open ends of the sample container **10**.

(17) In yet another variant, as illustrated in **Figure 2**, the first **35** and second **40** end seals have a second side **155**. The second side **155** has a substantially flat surface **160** to mate with a flat inner side **165** of either of the first **85** and second **90** securing caps.

(18) In a further variant of the invention, as illustrated in **Figure 6**, at least one of the first **35** and second **40** end seals has a membrane central portion **170**. The central portion **170** permits introduction of a syringe needle through the end seals **35, 40**.

(19) In still a further variant, the sample container **10** is formed from material selected from the group that includes glass, steel and plastic.

(20) In another variant, as illustrated in **Figure 4**, the outside diameter **180** of the sample container **10** ranges from 8 mm to 60 mm.

(21) In still another variant, as illustrated in **Figure 4**, the overall length **185** of the sample container **10** ranges from 20 mm to 150 mm.

(22) In yet another variant, the sample container **10** has a capacity ranging from 2 ml to 2400 ml.

(23) In a further variant of the invention, as illustrated in **Figures 3, 5** and **7-12**, a fluid sampling device **190** with dual-opening sample containers **10** includes the following components. At least one sample container **10** is provided. The container **10** is formed of substantially rigid, fluid impermeable material and has a hollow cavity **20** in communication with first **25** and second **30** open ends. First **35** and second **40** end seals are provided. The end seals **35, 40** are sized and shaped to fit sealably the first **25** and second **30** open ends. A first elastic member **45** is provided. The first elastic member **45** urges the first **35** and second **40** end seals to removably close the first **25** and second **30** open ends. A support platform **195** is provided. The support platform **195** is removably attached to the sample container **10** and has a fixture **200** for removable connection to a raising and lowering device (not shown). The support platform **195** has first **205** and second **210** movable attachment members. The

attachment members **205, 210** are sized, shaped and located to removably engage the first **35** and second **40** end seals.

A trigger **215** is provided. The trigger **215** is located to move the attachment members **205, 210** from a first position **220** to a second position **225**. When the sample container **10** is attached to the support platform **195** and the first **35** and second **40** end seals are engaged by the first **205** and second **210** attachment members in the first position **220,** the sample container **10** will be open. The support platform **195** may then be lowered into a fluid source (not shown) by the raising and lowering device and the trigger **215** pulled to move the first **205** and second **210** attachment members to the second position **225** releasing the first **35** and second **40** end seals. This permits the first elastic member **45** to urge the first **35** and second **40** end seals to seal the first **25** and second **30** open ends of the sample container **10**. This causes a fluid sample **235** to be sealed within the sample container **10,** as illustrated in **Figure 1**. The support platform **195** may then be withdrawn from the fluid source with the sealed sample container **10** and the fluid sample **235.**

(24) In a variant, as illustrated in **Figures 3, 5** and **7-12,** a trigger sheath **240** is provided. The sheath **240** is sized and shaped to fit slidably over the trigger **215** and is attached at a first end **245** to the support platform **195** and extends upwardly about the trigger **195.**

(25) In another variant, as illustrated in **Figures 3, 5** and **7-11,** a second elastic member **250** is provided. The second elastic member **250** urges the attachment members **205, 210** to the first position **220.**

(26) In still another variant, first **50** and second **55** activating protrusions are provided. Each of the activating protrusions **50, 55** extends outwardly from outer ends **60, 65** of the first

35 and second **40** end seals and is sized, shaped, and located to removably engage the movable attachment members **205, 210**.

(27) In yet another variant, the activating protrusion **205, 210** include holes **75**, loops (not shown) or hooks (not shown) for removable engagement of the movable attachment member **205, 210**.

(28) In a further variant, the first **35** and second **40** end seals include holes **80**, loops (not shown) and hooks (not shown) for attachment to the first elastic member **45**.

(29) In still a further variant, the first elastic member **45** is disposed within the hollow cavity **20**.

(30) In yet a further variant, as illustrated in **Figure 12**, the first elastic member **45** is disposed outside of the sample container **10**.

(31) In another variant of the invention, as illustrated in **Figures 1** and **2**, first **85** and second **90** securing caps are provided. The securing caps **85, 90** are sized and shaped to retain the first **35** and second **40** end seals in sealable connection with the first **25** and second **30** open ends of the sampling container **10**.

(32) In still another variant, as illustrated in **Figures 2** and **6**, the first **25** and second **30** open ends of the sampling container **10** have an external thread **250** and the first **85** and second **90** securing caps have a mating, internal thread **255**.

(33) In yet another variant, as illustrated in **Figure 2A**, the first **25** and second **30** open ends of the sampling container **10** have an external bayonet mount **260** and the first **85** and second **90** securing caps have a mating, internal bayonet mount **265**.

(34) In a further variant, as illustrated in **Figure 1**, at least one of the first **85** and second **90** securing caps includes a septa **115** that permits introduction of a syringe needle **120** and subsequent resealing of the securing cap **85, 90**.

(35) In still a further variant, as illustrated in **Figures 3** and **5**, the support platform **195** has a hollow body **280**. The hollow body **280** is sized and shaped to enclose the sample container **10**.

(36) In yet a further variant, the support platform **195** further comprises at least one fluid-permeable protective end cover **285**. The end cover **285** partially encloses an open end **290** of the hollow body **280**.

(37) In still a further variant, the fixture **200** for removable connection to a raising and lowering device is attached to the end cover **285**.

(38) In another variant, as illustrated in **Figures 9-11**, the sampling container **10** is sized and shaped to substantially enclose the support platform **195** within outer horizontal dimensions **295** of the sample container **10**.

(39) In still another variant, as illustrated in **Figure 2**, the first **35** and second **40** end seals include a substantially rigid core **125**. The core **125** is surrounded by a resilient material.

(40) In yet another variant, the substantially rigid core **125** and the resilient material are coated with substantially chemically inert material.

(41) In a further variant, the substantially chemically inert material is selected from the group that includes tetrafluoroethene, polytetrafluoroethene, perfluoralkoxy and fluoroethylpropylene.

(42) In still a further variant, as illustrated in **Figures 2, 4, 8, 11** and **12**, the first **35** and second **40** end seals include a compressible seal **140**. The seal **140** permits an elevation of fluid pressure within the sample container **10** upon compression of the seal **140**.

(43) In yet a further variant, at least one of the first **35** and second **40** end seals is formed of resilient material. The resilient material permits an elevation of fluid pressure within the sample container **10** upon compression of the seal **35, 40**.

(44) In still a further variant, as illustrated in **Figures 2, 4, 8** and **11**, the first **35** and second **40** end seals have a first side **150**. The first side **150** is substantially conical and is sized and shaped to fit sealably into the first **25** and second **30** open ends of the sample container **10**.

(45) In another variant of the invention, as illustrated in **Figure 2**, the first **35** and second **40** end seals have a second side **155**. The second side **155** has a substantially flat surface **160** to mate with a flat inner side **165** of either the first **85** or second **90** securing caps.

(46) In still another variant, as illustrated in **Figure 6**, at least one of the first **35** and second **40** end seals have a membrane central portion **170**. The central portion **170** permits introduction of a syringe needle through the end seals **35, 40**.

(47) In yet another variant, the sample container **10** is formed from material selected from the group that includes glass, steel and plastic.

(48) In a further variant, as illustrated in **Figure 4**, the outside diameter **180** of the sample container **10** ranges from 8 mm to 60 mm.

(49) In still a further variant, as illustrated in **Figure 4**, the overall length **185** of the sample container **10** ranges from 20 mm to 150 mm.

(50) In yet a further variant, the sample container **10** has a capacity ranging from 2 ml to 2400 ml.

(51) In another variant of the invention, a method of sampling fluid using a fluid sampling device **190** with dual-opening sample containers **10**, includes the steps of providing at least one sample container **10**. The container **10** is formed of substantially rigid, fluid impermeable material and has a hollow cavity **20** in communication with first **25** and second **30** open ends of the sample container **10**. Providing first **35** and second **40** end seals for the container **10**. The end seals **35, 40** are sized and shaped to fit sealably to the first **25** and second **30** open ends. Providing a first elastic member **45**. The first elastic member **45** urges the first **35** and second **40** end seals to removably close the first **25** and second **30** open ends.

Providing a support platform **195**. The support platform **195** is removably attached to the sample container **10** and has a fixture **200** for removable connection to a raising and lowering device. The support platform **195** has first **205** and second **210** movable attachment members. The attachment members **205, 210** are sized, shaped and located to removably engage the first **35** and second **40** end seals. Providing a trigger **215**. The trigger **215** is located to move the attachment members **205, 210** from a first position **220** to a second position **225**. Attaching the support platform **195** to the sample container **10** with the movable attachment members **205, 210** in said first position **220**, engaging the first **35** and second **40** end seals so as to maintain the end seals **35, 40** in an open position **240**. Attaching the support platform **195** to the raising and lowering device **175**. Lowering the support platform **195** into a fluid source. Pulling the trigger **215** to move the attachment members **205, 210** from the first position **220** to the second position **225**, thereby sealing the first **25** and second **30** open ends with a fluid sample **235** inside of the hollow cavity **20**. Raising the support platform **195**

from the fluid source. Removing the sealed sample container **10** from the support platform **195**.

When the sample container **10** is removed from the support platform **195**, it may be sent for testing and examination without contamination from elements (not shown) outside the fluid source.

(52) In yet another variant, the method of sampling fluid using a fluid sampling device **190** with dual-opening sample containers **10** includes the additional steps of providing first **85** and second **90** securing caps. The securing caps **85, 90** are sized and shaped to retain the first **35** and second **40** end seals in sealable connection with the first **25** and second **30** open ends of the sampling container **10**. Attaching the first **85** and second **90** securing caps to the first **25** and second **30** open ends of the of the sample container **10**.

(53) In a final variant, the method of sampling fluid using a fluid sampling device **190** with dual-opening sample containers **10** includes the additional steps of providing at least one of the first **35** and second **40** end seals with a membrane central portion **170**. The central portion **170** permits introduction of a syringe needle **120** through the end seal **35, 40**. Providing first **85** and second **90** securing caps. The securing caps **85, 90** are sized and shaped to retain the first **35** and second **40** end seals in sealable connection with the first **25** and second **30** open ends of the sampling container **10**. At least one of the securing caps **85, 90** has a septa **115** to permit introduction of a syringe needle and subsequent resealing of the securing cap **85, 90**. Inserting a syringe needle **120** through the septa **115** and the membrane central portion **170**. Withdrawing a fluid sample **235** from the sample container **10**. Removing the syringe needle from the septa **115** and the membrane central portion **170**. Depositing the fluid sample **235** in a test facility.

The fluid sampling device with dual-opening sample containers **190** and dual-opening sample container **10** have been described with reference to particular embodiments. Other modifications and enhancements can be made without departing from the spirit and scope of the claims that follow.